The Phase III Expansion of the White Street Sanitary Landfill

Greensboro, North Carolina

Construction Permit Application

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Construction Quality Assurance Plan

WHITE STREET SANITARY LANDFILL
GREENSBORO, NORTH CAROLINA

CONSTRUCTION QUALITY ASSURANCE PLAN

Prepared for:

The City of Greensboro

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CONSTRUCTION QUALITY ASSURANCE PLAN

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GENERAL

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GENERAL

1.1 INTRODUCTION

This Construction Quality Assurance (CQA) Plan has been prepared to provide the Owner, Engineer, and CQA Consultant the means to govern the construction quality and to satisfy landfill certification requirements under current solid waste management regulations.

More specifically, this CQA Plan addresses the soils and geosynthetics components of the liner and leachate collection/removal (LCR) systems. The liner system, as referenced herein, generally consists of a soil subgrade and a composite liner (consisting of a compacted soil liner and an overlying HDPE geomembrane liner). The LCR system consists of a granular drainage material with perforated collection piping, manholes, and fittings. General references in this Plan to the various components as the "liner or LCR system(s)" are intended to be as described herein.

The CQA Plan is divided into the following sections:

- Section 1.0 General
- Section 2.0 Soil Liner Construction Quality Assurance
- Section 3.0 Geomembrane Liner Construction Quality Assurance
- Section 4.0 LCR Construction Quality Assurance
- Section 5.0 Geotextile Construction Quality Assurance
- Section 6.0 High Density Polyethylene Pipe, Manholes, and Fittings Construction Quality Assurance
- Section 7.0 Geonet Construction Quality Assurance
- Section 8.0 GCL Construction Quality Assurance
- Section 9.0 Surveying Construction Quality Control
- Section10.0 Construction Quality Assurance Documentation

1.2 DEFINITIONS RELATING TO CONSTRUCTION QUALITY

1.2.1 Construction Quality Assurance (CQA)

In the context of this Plan, construction quality assurance is defined as a planned and systematic program employed by the Owner to assure conformity of the liner systems, LCR systems, and protective cover system installation with Contract Drawings, and the project specifications. CQA is provided by the CQA Consultant as a representative of the Owner and is independent from the Contractor and all manufacturers. The CQA program is designed to provide adequate confidence that items or services meet contractual and regulatory requirements and will perform satisfactorily in service.

1.2.2 Construction Quality Control (CQC)

Construction Quality Control refers to actions taken by manufacturers, fabricators, installers, or the Contractor to ensure that the materials and the workmanship meet the requirements of this CQA Plan and the project specifications. In the case of the liner and LCR systems, CQC is provided by the Contractor's CQC Consultant. In the case of geosynthetic components, material quality control (QC) is provided by the manufacturer's certification and the CQC for the installation of the various geosynthetics is provided by the Contractor's CQC Consultant. The manufacturer's specifications and quality control (QC) requirements are included in this CQA Plan by reference only. A complete updated version of each geosynthetic component manufacturer's QC Plan will be incorporated as part of the Contractor's CQC Plan.

1.2.3 CQC/CQA Certification Document

At the completion of construction and prior to placement of waste in the landfill, a certification document will be prepared by the CQA Consultant and be submitted to State Solid Waste Regulators. The certification report will include all QC testing performed by the Geosynthetics Manufacturers, all CQC testing performed by the CQC Consultant, or Geosynthetic Installers, and all CQA conformance testing performed by the CQA Consultant.

1.2.4 Discrepancies Between Documents

The CQA Plan is intended to be a supporting document to improve the overall documentation of the Work. The CQA Plan is less specific from the project specifications, and conflicts may exist between the documents. The Contractor is instructed to bring discrepancies to the attention of the Engineer or CQA Consultant for resolution. The Engineer has the sole authority to determine resolution of discrepancies existing within the Contract Documents. Unless otherwise determined by the Engineer, the more stringent requirement shall be the controlling resolution. Reference is made to the project specifications, Section 00700 - General Conditions.

1.3 PARTIES TO CONSTRUCTION QUALITY ASSURANCE

1.3.1 Description of the Parties

The parties to Construction Quality Assurance and Quality Control include the Owner, Project Manager, Engineer, Contractor, Geosynthetics Manufacturer, Geosynthetics Installer, CQA Consultant, Geosynthetics CQA Laboratory, Soils CQA Laboratory, CQC Consultant, Geosynthetics CQC Laboratory, and Soils CQC Laboratory. The lines of authority and communications between each of the parties involved in the CQA and CQC are illustrated in Figure 1 (Page 4).

1.3.1.1 Owner

The Owner is the City of Greensboro, who owns and/or is responsible for the facility.

1.3.1.2 Project Manager

The Project Manager is the official representative of the Owner. The Project Manager serves as communications coordinator for the project, initiating the resolution, preconstruction, and construction meetings outlined in Section 1.7. The Project Manager shall also be responsible for proper resolution of all quality issues that arise during construction. The Project Manager is HDR Engineering, Inc. of Charlotte, NC.

1.3.1.3 Engineer

The Engineer is responsible for the engineering design, drawings, plans and project specifications for the liner system and protective cover system. The Engineer is HDR Engineering, Inc. of Charlotte, NC.

1.3.1.4 Contractor

The Contractor is responsible for the construction of the subgrade, construction of the subbase (as applicable), soil liner berms, soil and geomembrane liners, anchor trench excavation and backfill, and for placement of the LCR system. The Contractor is responsible for submittal coordination and the overall CQC on the project.

1.3.1.5 Geosynthetics Manufacturer

The Geosynthetics Manufacturer(s) is(are) responsible for the production of geomembranes, geonets, and geotextiles. The manufacturers are responsible for Quality Control (QC) during manufacture of the geosynthetic components, certification of the properties of the geosynthetic components, and field installation criteria.

1.3.1.6 Geosynthetics Installer

The Geosynthetics Installer(s) is(are) a subcontractor of the Contractor and is(are) responsible for field handling, storing, placing, seaming, protection of (against wind, etc.), and other aspects of the geosynthetics installations, including the geomembranes and geotextiles. The Installer may also be responsible for transportation of these materials to the site, and for the preparation and completion of anchor trenches.

Figure 1 - CQA/CQC Lines of Authority and Communication

1.3.1.7 Construction Quality Assurance Consultant

The CQA Consultant is a representative of the Owner and is responsible for observing, testing, and documenting activities related to the CQC/CQA of the earthworks at the site, and the installation of the geosynthetic components of the liner and leachate collection/removal systems. The CQA Consultant is also responsible for issuing a facility certification report, sealed by a Professional Engineer registered in North Carolina.

1.3.1.8 Geosynthetics Construction Quality Assurance Laboratory

The Geosynthetics CQA Laboratory is a party, independent from the Owner, that is responsible for conducting tests on conformance samples of geosynthetics used in the liner and LCR systems. The Geosynthetics CQA Laboratory service cannot be provided by any party involved with the manufacture, fabrication, or installation of any of the geosynthetic components.

1.3.1.9 Soils Construction Quality Assurance Laboratory

The Soils Construction Quality Assurance Laboratory is a party, independent from the Owner, that is responsible for conducting geotechnical tests on conformance samples of soils used in the liner system. The Soils CQA Laboratory service cannot be provided by any party involved with the Contractor.

1.3.1.10 Construction Quality Control Consultant

The CQC Consultant is a representative of the Contractor and is responsible for the earthwork and soil liner quality control sampling and testing. The term CQC Consultant shall be used to designate the Engineer in charge of the quality control work. The personnel of the CQC Consultant also includes Quality Control Monitors who are also located at the site for construction observation and monitoring. The CQC Consultant is responsible for the timely conveyance of CQC testing results to the CQA Consultant.

1.3.1.11 Geosynthetics Construction Quality Control Laboratory

The Geosynthetics CQC Laboratory is a party, independent from the Contractor, that is responsible for conducting tests on conformance samples of geosynthetics used in the liner and LCR systems.

1.3.1.12 Soils Construction Quality Control Laboratory

The Soils Construction Quality Control Laboratory is a party, independent from the Contractor, that is responsible for conducting geotechnical tests on conformance samples of soils used in the liner system.

1.3.2 Qualifications of the Parties

The following qualifications are required of all parties involved with the manufacture, fabrication, installation, transportation, and CQC/CQA of all materials for the liner and LCR systems. Where applicable, these qualifications must be submitted by the Contractor to the Project Manager for review and approval.

1.3.2.1 Contractor

Qualifications of the Contractor are specific to the construction contract and independent of this CQA Plan.

1.3.2.2 Geosynthetics Manufacturers

Each Geosynthetics Manufacturer must satisfy the qualifications presented in the project specifications and must be prequalified and approved by the Project Manager.

The physical properties of each geosynthetic product must be certified by the geosynthetics manufacturer. The properties certified must include, at a minimum, those identified in the project specifications. Manufacturers certification must be approved by the CQA Consultant before the product is used.

1.3.2.3 Geosynthetic Installer(s)

The Geosynthetic Installer(s) will be trained and qualified to install the geosynthetics components of the liner system. Each Geosynthetics Installer must meet the requirements of the project specifications and be approved by the Project Manager. The Geomembrane Installer must be approved by the Geomembrane Manufacturer.

1.3.2.4 Construction Quality Assurance Consultant

The CQA Consultant will act as the Owner's CQA Representative and will report to the Project Manager. The CQA Consultant will perform conformance testing to satisfy the requirements of this CQA Plan, will observe the CQC work performed by the CQC Consultant, and will prepare the certification document incorporating both CQA and CQC test data. The CQA Consultant will have experience in the CQC/CQA aspects of landfill liner system construction and soils testing, and be familiar with ASTM and other related industry standards. The activities of the CQA Consultant will be performed under the supervision of a Registered Professional Engineer.

1.3.2.5 Construction Quality Control Consultant

The CQC Consultant will be a party, independent from the Contractor. The CQC Consultant will be experienced with soils, including soil liners, and geosynthetics, including geomembranes, geonets, and geotextiles. The CQC Consultant will satisfy

the requirements of the project specifications and be approved by the Project Manager. The activities of the CQC Consultant will be performed under the supervision of a Registered Professional Engineer.

1.3.2.6 Geosynthetics Construction Quality Control Laboratory

The Geosynthetics CQC Laboratory is a subcontractor of the CQC Consultant and will have experience in testing geosynthetics and be familiar with ASTM, NSF, and other applicable test standards. The Geosynthetics CQC Laboratory will be capable of providing test results within 24 hours or a reasonable time after, as agreed to at the outset of the project, receipt of samples, and will maintain that standard throughout the installation.

1.4 SCOPE OF CONSTRUCTION QUALITY ASSURANCE PLAN

The scope of this CQA Plan includes the CQA of the soils and geosynthetic components of the liner and LCR systems for the subject facility. The CQA for the selection, evaluation, and placement of the soils is included in the scope. This document is intended to be used in concert with the CQC requirements presented in the project specifications.

1.5 UNITS

In this CQA Plan, all properties and dimensions are expressed in U.S. units.

1.6 REFERENCES

The CQA Plan includes references to the most recent version of the test procedures of the American Society of Testing and Materials (ASTM), the Federal Test Method Standards (FTMS), the "Standards for Flexible Membrane Liners" of the National Sanitation Foundation (NSF), and the "Geosynthetic Research Institute" (GRI).

1.7 SITE AND PROJECT CONTROL

To guarantee a high degree of quality during installation, clear, open channels of communication are essential. To that end, meetings are critical.

1.7.1 CQA/CQC Resolution Meeting

Prior to field mobilization by the Contractor, a Resolution Meeting will be held. This meeting will include all parties then involved, including the Project Manager, the CQA Consultant, the Engineer, the Contractor, and the CQC Consultant.

The purpose of this meeting is to begin planning for coordination of tasks, anticipate any problems which might cause difficulties and delays in construction, and, above all,

review the CQA and CQC Plans to all of the parties involved. It is very important that the rules regarding testing, repair, etc., be known and accepted by all.

This meeting should include all of the following activities:

- communicate to all parties any relevant documents;
- review critical design details of the project;
- review the seam layout drawing provided by the Geomembrane/Geosynthetic Installer.
- review the site-specific CQA and CQC Plans;
- make any appropriate modifications to the CQA and CQC Plans to ensure that they specify all testing activities that are necessary;
- reach a consensus on the CQA/CQC quality control procedures, especially on methods for determining acceptability of the soils and geosynthetics;
- review the proposed liner system and protective cover system;
- decide the number of spare seaming units for geomembranes to be maintained on site by the Geomembrane/Geosynthetic Installer (this number depends on the number of seaming crews and on the type of seaming equipment);
- select testing equipment and review protocols for testing and placement of general earthwork materials;
- confirm methods for the soil liner material selection testing, acceptable zone determinations, and test strip installation;
- confirm the methods for documenting and reporting, and for distributing documents and reports; and
- confirm the lines of authority and communication.

The meeting will be documented by the Project Manager and minutes will be transmitted to all parties.

1.7.2 CQA/CQC Preconstruction Meeting

A Preconstruction Meeting will be held at the site prior to placement of the geomembrane liner. At a minimum, the meeting will be attended by the Project Manager, Engineer, the CQA Consultant, the Contractor, the CQC Consultant, and the Geosynthetic/Geomembrane Installation Superintendent.

Specific topics considered for this meeting include:

- make any appropriate modifications to the CQA and CQC Plans;
- review the responsibilities of each party;
- review lines of authority and communication;
- review methods for documenting and reporting, and for distributing documents and reports;
- establish protocols for testing;
- establish protocols for handling deficiencies, repairs, and retesting;
- review the time schedule for all operations;
- establish rules for writing on the geomembrane, i.e., who is authorized to write, what can be written, and in which color;
- outline procedures for packaging and storing archive samples;
- review panel layout and numbering systems for panels and seams;
- establish procedures for use of the extrusion seaming apparatus, if applicable;
- establish procedures for use of the fusion seaming apparatus, if applicable;
- finalize field cutout sample sizes;
- review seam testing procedures;
- review repair procedures; and
- establish soil stockpiling locations (if any).

The meeting will be documented by the Project Manager and minutes will be transmitted to all parties. The Resolution Meeting and the Preconstruction Meeting may be held as one meeting or separate meetings, depending on the direction of the Project Manager.

1.7.3 Daily and Weekly CQA/CQC Progress Meetings

A weekly progress meeting will be held between the Project Manager, the CQA Consultant, the Contractor, the CQC Consultant, the Geosynthetic/Geomembrane Installation Superintendent, and representatives from any other involved parties. This meeting will discuss current progress, planned activities for the next week, and any new business or revisions to the work. The CQA Consultant will log any problems, decisions, or questions arising at this meeting in his daily report. Any matter requiring action which is raised in this meeting will be reported to the appropriate parties.

A daily meeting will be held between the CQA Consultant, the CQC Consultant, the Geosynthetic/ Geomembrane Installation Superintendent, and representatives from any other involved parties. This meeting will discuss current progress, planned activities for the next shift, and any new business or revisions to the work. The CQA Consultant will log any problems, decisions, or questions arising at this meeting in his daily report. Any matter requiring action which is raised in this meeting will be reported to the appropriated parties.

Meeting frequency will depend on the schedule of the project and the mutual agreement of all parties involved.

1.7.4 Problem or Work Deficiency Meetings

A special meeting will be held when and if a problem or deficiency is present or likely to occur. At a minimum, the meeting will be attended by all interested parties, the Contractor, the Project Manager, and the CQA Consultant. If the problem requires a design modification, the Engineer should also be present. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

- define and discuss the problem or deficiency;
- review alternative solutions; and
- implement an action plan to resolve the problem or deficiency.

The meeting will be documented by the Project Manager and minutes will be transmitted to affected parties.

SECTION 2.0

SOIL LINER CONSTRUCTION QUALITY ASSURANCE

SECTION 2.0
SOIL LINER CONSTRUCTION QUALITY ASSURANCE

2.1 INTRODUCTION

This section of the CQA Plan addresses the soil components of the liner system, and outlines the soils CQA program to be implemented with regard to materials confirmation, laboratory and field confirmation test requirements, overview and interfacing with the Contractor's CQC Program, and resolution of problems.

2.2 EARTHWORK CONSTRUCTION

2.2.1 Subgrade

The subgrade material below the controlled fill will be prepared by the Contractor prior to the placement of fill. The CQC Consultant will provide density testing of the pre-fill subgrade at the frequency specified in the project specifications. The CQA Consultant will observe the proofroll by the Contractor, review the density test data provided by the CQC Consultant, and provide verification that the pre-fill subgrade is acceptable. The CQA Consultant may conduct confirmation density testing as deemed appropriate.

2.2.2 Structural/Controlled Fill

The Contractor shall place fill in accordance with the project specifications. The CQC Consultant shall provide testing of the controlled fill material in accordance with the project specifications. The CQA Consultant will provide confirmation testing of the controlled fill as deemed appropriate.

2.3 SOIL LINER SYSTEM

2.3.1 Soil Liner Subgrade

Testing will be conducted by the CQC Consultant as observed by the CQA Consultant. The subgrade material below the subbase is composed of controlled fill and in situ soils. The surface of the subgrade will be prepared prior to the construction of the subbase. The CQA Consultant will visually examine the surface of the subgrade to verify that any potentially deleterious materials have been removed.

2.3.2 Soil Liner Material

The soil liner material shall be placed and compacted in accordance with the project specifications. The CQC Consultant shall conduct field density and moisture tests at the frequency presented in the project specifications. The CQA Consultant shall provide conformance tests at a frequency of approximately 10 percent of the required CQC tests. Additional CQA conformance testing may be performed at the discretion of the CQA Consultant.

Hydraulic Conductivity, Atterberg Limits, and Percent Fines testing of the soil liner material shall be performed by the CQC Consultant in accordance with the project specifications. Additional CQA conformance testing may be performed at the discretion of the CQA Consultant.

Thickness measurement shall be conducted in accordance with the project specifications by the CQC Consultant and observed by the CQA Consultant.

2.4 SOILS TESTING

2.4.1 Test Methods

All testing used to evaluate the suitability or conformance of soils materials will be carried out in accordance with the project specifications.

2.4.2 Soils Testing Requirements

The soil CQC testing must comply with the minimum frequencies presented in the project specifications. The frequency of CQA testing required will be determined by the CQA Consultant in light of the potential variability of materials and the acceptance/failure rate of the CQC testing.

2.5 SOILS CONSTRUCTION QUALITY ASSURANCE

CQA will be performed on all soil components of the liner construction. CQA evaluation will consist of: (1) monitoring the work and observing the CQC testing; and (2) performing laboratory and field conformance tests. Laboratory CQA conformance tests will be conducted on samples taken at the borrow source, stockpile, and during the course of the work prior to construction. Field CQA conformance tests will be conducted during the course of the work.

2.5.1 Monitoring

The CQA Consultant shall monitor and document the construction of all soil components. Monitoring the construction work for the subbase soil, and the soil component of the liner system, includes the following:

- observing CQC testing to determine the water content and other physical properties of the subbase and soil component of the liner system during compaction and compilation of the data;
- monitoring the loose thickness of lifts as placed;
- monitoring the action of the compaction and/or heavy hauling equipment on the construction surface (i.e., penetration, pumping, cracking. etc.); and
- monitoring the number of passes used to compact each lift.

2.5.2 Construction Quality Assurance Judgmental Testing

During construction, the frequency of conformance testing may be increased at the discretion of the CQA Consultant when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- the rollers slip during rolling operation;
- the lift thickness is greater than specified;
- the fill material is at an improper moisture content;
- fewer than the specified number of roller passes are made;
- dirt-clogged rollers are used to compact the material;
- the rollers may not have used optimum ballast;
- the fill materials differ substantially from those specified; or
- the degree of compaction is doubtful.

2.5.3 Perforations in Soil Liner

Perforations that must be filled will include, but not be limited to, the following:

- nuclear density test probe locations;
- permeability sampling locations; and/or
- thickness checks.

Unless otherwise noted, or as directed by the Project Manager, all perforations of the subbase by probes or sample tubes will be backfilled in accordance with project specifications. The CQA Consultant will observe and confirm that adequate procedures are being employed.

2.5.4 Deficiencies

If a defect is discovered in the earthwork product, the CQC Consultant will immediately determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQC Consultant will determine the extent of the deficient area by additional tests, observations, a review of records, or other appropriate means. If the defect is related to adverse site conditions, such as overly wet soils or surface desiccation, the CQC Consultant will define the limits and nature of the defect.

2.5.5.1 Notification

After determining the extent and nature of a defect, the CQC Consultant will notify the Project Manager, the CQA Consultant, and Contractor and schedule appropriate retests when the work deficiency is corrected. The CQA Consultant shall observe all retests on defects.

2.5.5.2 Repairs and Retesting

The Contractor will correct the deficiency to the satisfaction of the CQA Consultant. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the CQC Consultant will develop and present to the Project Manager and CQA Consultant suggested solutions for approval.

All retests recommended by the CQC Consultant must verify that the defect has been corrected before any additional work is performed by the Contractor in the area of the deficiency. The CQA Consultant will verify that all installation requirements are met and that all submittals are provided.

2.5.5.3 Penalties

Refer to Specification Section 02775.

SECTION 3.0

GEOMEMBRANE LINER CONSTRUCTION QUALITY ASSURANCE

SECTION 3.0
GEOMEMBRANE LINER
CONSTRUCTION QUALITY ASSURANCE

3.1 GEOMEMBRANE MANUFACTURER'S CERTIFICATION, AND CQA CONFORMANCE TESTING

3.1.1 Geomembrane Manufacturer's Certification

Compliance testing will be performed by the Geomembrane Manufacturer to demonstrate that the product meets the manufacturers' quality control and conformance test minimum standards for geomembrane specifications and exceeds the project specifications. Additional testing will be performed by the CQA Consultant for purposes of conformance evaluation. If the results of the Geomembrane Manufacturer's and the CQA Consultant's testing differ, the testing will be repeated by the CQA Consultant's laboratory, and the Geomembrane Manufacturer will be allowed to monitor this testing. The results of this latter series of tests will prevail, provided that the applicable test methods have been followed.

3.1.1.1 Raw Material

Prior to the installation of any geomembrane material, the Geomembrane Manufacturer will provide the CQA Consultant and the CQC Consultant with the following information as a bound document with the individual sections clearly identified:

- the origin (Resin Supplier's name and resin production plant), identification (brand name, number), and production date of the resin;
- a copy of the quality control certificates issued by the Resin Supplier;
- reports on the tests conducted by the Geomembrane Manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls assigned to the project; and
- a statement that the percentage of reclaimed polymer added to the resin is in accordance with the project specifications.

The CQA Consultant will review these documents and report any discrepancies with the above requirements to the Project Manager.

3.1.1.2 Geomembrane Manufacturing

Prior to the installation, the Geomembrane Manufacturer will provide the Contractor and the CQA Consultant with the following:

- a properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the project technical specifications, or equivalent;
- the sampling procedure and results of testing; and
- a certification that property values given in the properties sheet are minimum average roll values and are guaranteed by the Geomembrane Manufacturer.

The CQA Consultant will review these documents and verify that:

- the reported property values certified by the Geomembrane Manufacturer meet all of the project technical specifications;
- the measurements of properties by the Geomembrane Manufacturer are properly documented and that the test methods used are acceptable; and
- Report any discrepancies with the above requirements to the Project Manager.

3.1.1.3 Rolls and Sheets

Prior to shipment, the Geomembrane Manufacturer will provide the CQA Consultant and the CQC Consultant with a quality control certificate for each roll (HDPE geomembrane) or sheet (non-HDPE geomembrane) of geomembrane provided. The quality control certificate will be signed by a responsible party employed by the Geomembrane Manufacturer, such as the Production Manager. The quality control certificate will include:

- roll numbers and identification; and
- sampling procedures and results of quality control tests -- as a minimum, results will be given for thickness, tensile characteristics and tear resistance, evaluated in accordance with the methods indicated in the project specifications or equivalent methods approved by the Engineer.

The quality control certificate will be bound and included as part of the report required in Section 3.1.1.1.

The CQA Consultant will:

- verify that the quality control certificates have been provided at the specified frequency and that each certificate identified the rolls or sheets related to it;
- review the quality control certificates and verify that the certified roll or sheet properties meet the project technical specifications; and
- report any discrepancies with the above requirements to the Project Manager.

3.2 GEOMEMBRANE INSTALLATION

3.2.1 Transportation, Handling, and Storage

3.2.1.1 Transportation and Handling

The CQA Consultant will verify that:

- handling equipment used on the site is adequate, meets manufacturer's recommendations, and does not pose any risk of damage to the geomembrane; and
- the Geomembrane Installer's personnel handle the geomembranes with care.

Upon delivery at the site, the CQA Consultant will conduct a surface observation of all rolls and sheets for defects and damage. This examination will be conducted without unrolling rolls or unfolding sheets unless defects or damages are found or suspected. The CQA Consultant will indicate to the Project Manager:

- any rolls or sheets, or portions thereof, that should be rejected and removed from the site because they have severe flaws; and
- any rolls or sheets that have minor repairable flaws.

Refer to ASTM D4873 for detailed methods.

3.2.1.2 Storage

The CQA Consultant will document that the Contractor's storage of the geomembrane provides adequate protection against moisture, dirt, shock, and other sources of damage or contamination.

3.2.2 Earthwork

3.2.2.1 Surface Preparation

The CQC Consultant and the Geomembrane Installer will certify in writing that the surface on which the geomembrane will be installed meets line and grade, and the surface preparation requirements of the project specifications. The certificate of acceptance will be given by the CQC Consultant to the CQA Consultant prior to commencement of geomembrane installation in the area under consideration. The CQA Consultant will give a copy of this certificate to the Project Manager.

To ensure a timely covering of the soil liner surface, the Project Manager may allow subgrade acceptance in areas as small as one acre. After the supporting soil has been accepted by the Geomembrane Installer, it will be the Geomembrane Installer's responsibility to indicate to the Project Manager of any change in the supporting soil condition that may require repair work. If the CQA Consultant concurs with the Geomembrane Installer, then the Project Manager will ensure that the supporting soil is repaired.

3.2.2.2 Anchorage System

The CQA Consultant will verify that anchor trenches have been constructed and backfilled according to project specifications and design drawings.

3.2.3 Geomembrane Placement

3.2.3.1 Field Panel Identification

The CQA Consultant will document that the Geomembrane Installer labels each field panel with an "identification code" (number or letter-number consistent with the layout plan) agreed upon by the CQC Consultant, Geomembrane Installer, and CQA Consultant at the CQA/CQC Preconstruction Meeting, Section 1.7.2.

The Geomembrane Installer will establish a table or chart showing correspondence between roll numbers and field panel identification codes. This documentation shall be submitted to the CQC Consultant and CQA Consultant weekly for review and verification. The field panel identification code will be used for all quality control and quality assurance records.

3.2.3.2 Field Panel Placement

3.2.3.2.1 Location

The CQA Consultant will verify that field panels are installed at the location indicated in the Geomembrane Installer's layout plan, as approved or modified in Section 3.2.3.1.

3.2.3.2.2 Installation Schedule

The CQA Consultant will evaluate every change in the schedule proposed by the Geomembrane Installer and advise the Project Manger on the acceptability of that change. The CQA Consultant will verify that the condition of the supporting soil has not changed detrimentally during installation.

The CQA Consultant will record the identification code, location, and date of installation of each field panel.

3.2.3.2.3 Placement of Geomembrane

The CQA Consultant will verify that project specification related restrictions on placement of geomembrane are fulfilled. Additionally, the CQA Consultant will verify that the supporting soil has not been damaged by weather conditions.

The CQA Consultant will inform the Project Manager if the above conditions are not fulfilled.

3.2.3.2.4 Damage

The CQA Consultant will visually observe each panel, after placement and prior to seaming, for damage. The CQA Consultant will advise the Project Manager which panels, or portion of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected will be marked and their removal from the work area recorded by the CQA Consultant. Repairs will be made according to procedures described in the project specifications.

As a minimum, the CQA Consultant will document that:

- the panel is placed in such a manner that it is unlikely to be damaged; and
- any tears, punctures, holes, thin spots, etc., are either marked by the Geomembrane Installer for repair or the panel is rejected.

3.2.4 Field Seaming

3.2.4.1 Seam Layout

The Geomembrane Installer will provide the CQA Consultant with a seam layout drawing, i.e., a drawing of the facility to be lined showing all expected seams. The CQA Consultant and Engineer will review the seam layout drawing and verify that it is consistent with the accepted state of practice and this CQA Plan. In addition, no panels not specifically shown on the seam layout drawing may be used without the Project Manager's prior approval.

A seam numbering system compatible with the panel numbering system will be agreed upon at the Resolution and/or Preconstruction Meeting, Section 1.7. An on-going written record of the seams and repair areas shall be maintained by the Geomembrane Installer with weekly review by the CQA Consultant.

3.2.4.2 Requirements of Personnel

The Geomembrane Installer will provide the CQA Consultant with a list of proposed seaming personnel and their experience records. This document will be reviewed by the Project Manager and the CQA Consultant for compliance with project specifications.

3.2.4.3 Seaming Equipment and Products

Field seaming processes must comply with project specifications. Proposed alternate processes will be documented and submitted to the CQA Consultant for his approval. Only seaming apparatus which have been specifically approved by make and model will be used. The CQA Consultant will submit all documentation to the Engineer for his concurrence.

3.2.4.4 Nondestructive Seam Continuity Testing

The Geomembrane Installer will nondestructively test all field seams over their full length using test methods approved by the project specifications. The CQA Consultant shall periodically observe the nondestructive testing to ensure conformance with this CQA Plan and the project specifications.

For approximately 10% of the noncomplying tests, the CQA Consultant will:

- observe continuity testing of the repaired areas performed by the Geomembrane Installer;

- confirm the record location, date, test unit number, name of tester, and compile the record of testing provided by the Geomembrane Installer;

- provide a walkthrough inspection of all impacted seam areas and verify that the areas have been tested in accordance with the CQA Plan and project specifications; and

- verify that the Geomembrane Installer has marked repair areas with the appropriate color-coded marking pencil.

3.2.4.5 Destructive Seam Testing

Destructive seam tests will be performed by the CQC consultant at locations and a frequency in accordance with the project specifications. The CQA Consultant will perform conformance tests on a minimum of 10% of the CQC destructive seam test samples obtained. Additional destructive seam tests may be required at the CQA Consultant's discretion. Selection of such locations may be prompted by suspicion of contamination, excessive grinding, offcenter and/or offset seams, or any other potential cause of imperfect seaming.

3.2.4.5.1 Geosynthetics Construction Quality Assurance Laboratory Testing

Destructive test samples will be packaged and shipped by the CQA Consultant in a manner that will not damage the test sample. The Project Manager will be responsible for storing the archive samples. These procedures will be fully outlined at the Resolution Meeting, Section 1.7. Test samples will be tested by the Geosynthetics CQA Laboratory.

Conformance testing will include "Seam Strength" and "Peel Adhesion" (ASTM D638 using one-inch strips and a strain rate of two inches per minute) in accordance with ASTM D4437 and project specifications. All geomembrane destructive test samples that fail to meet project specifications shall be saved and sent to the CQA Consultant for observation.

The Geosynthetics CQA Laboratory will provide preliminary test results no more than 24 hours after they receive the samples. The CQA Consultant will review laboratory test results as soon as they become available.

3.2.4.5.2 Defining Extent of Destructive Seam Test Failure

All defective seam test failures must be bounded by seam tests from which destructive samples passing laboratory tests have been taken. The CQA Consultant will document repair actions taken in conjunction with all destructive seam test failures.

3.2.5 Defects and Repairs

All seams and nonseam areas of the geomembrane will be examined by the CQC Consultant for identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Each suspected location, both in seam and nonseam areas, will be nondestructively tested using methods in accordance with the project specifications. Each location which fails the nondestructive testing will be marked by the CQC Consultant and repaired by the Geomembrane Installer. Repair procedures will be in accordance with project specifications or procedures agreed to by the Project Manager in the preconstruction meeting. The CQA Consultant will observe all repair procedures and advise the Project Manager of any problems.

3.2.6 Backfilling of Anchor Trench

Anchor trenches will be will be backfilled and compacted as outlined in the project specifications. The CQA Consultant will review the backfilling operation and advise the Project Manager of any problems.

3.2.7 Liner System Acceptance

The Geomembrane Installer and the Geosynthetic Manufacturers will retain all ownership and responsibility for the geosynthetics in the landfill cell until acceptance by the Owner.

The geomembrane component of the liner system will be accepted by the Owner when:

- the installation is finished;
- verification of the adequacy of all seams and repairs, including associated testing, is complete;
- CQC Consultant provides the CQA Consultant and Project Manager with a final copy of the nondestructive test documentation, repair information, and as-built drawings.
- CQA Consultant furnishes the Project Manager with certification that the geomembrane was installed in accordance with the Geosynthetic Manufacturer's recommendations as well as the Plans and project specifications;
- all documentation of installation is completed including the CQA Consultant's final report; and

- certification by the CQA Consultant, including Record Drawing(s), sealed by a Professional Engineer registered in the state in which the project is located, has been received by the Project Manger.

The CQA Consultant will certify that the installation has proceeded in accordance with this CQA Plan and the project specifications for the project except as noted to the Project Manager.

3.2.8 Materials in Contact with Geomembranes

The quality assurance procedures indicated in this Subsection are only intended to assure that the installation of these materials does not damage the geomembrane. Although protective geosynthetics and geotextiles have been incorporated into the liner system, all reasonable measures to protect the geomembrane and provide additional quality assurance procedures are necessary to assure that systems built with these materials will be constructed to ensure proper performance.

3.2.8.1 Soils

Prior to placement, the CQA Consultant will visually confirm that all soil materials to be placed against the geomembrane comply with project specifications. The Geomembrane Installer will provide the CQA Consultant a written surface acceptance certificate in accordance with Section 3.2. 1. All soil materials shall be placed and compacted in accordance with project specifications.

3.2.8.2 Sumps and Appurtenances

The CQA Consultant will verify that:

- installation of the geomembrane in appurtenance areas, and connection of the geomembrane to appurtenances have been made according to the project specifications;
- extreme care is taken while seaming around appurtenances since neither nondestructive nor destructive testing may be feasible in these areas;
- the geomembrane has not been visibly damaged while making connections to appurtenances;
- The installation of the geomembrane shall be exercised so as not to damage sumps; and

- the CQA Consultant will inform the Project Manager if the above conditions are not fulfilled.

SECTION 4.0

LCR CONSTRUCTION QUALITY ASSURANCE

SECTION 4.0
LCR CONSTRUCTION QUALITY ASSURANCE

4.1 INTRODUCTION

This section of the CQA plan addresses the sand and gravel drains, and the soil buffer layer of the LCR system. By reference to Sections 5.0 and 6.0 of this CQA Plan, this section also addresses the perforated plastic pipes and geotextile filters and cushions that are included in the LCR system. This section outlines the CQA program to be implemented with regard to materials confirmation, laboratory and field test requirements, overview and interfacing with the Contractor's CQC Program, and resolution of problems.

4.2 GRANULAR LEACHATE COLLECTION SYSTEM

4.2.1 Protective Cover (Leachate Collection Layer) Material

The LCR layer shall be placed and compacted in accordance with the project specifications. The CQC Consultant will provide gradation and density testing of the granular material at the frequency specified in the project specifications. The CQA Consultant will observe that placement of the granular material is done in a manner to protect the geomembrane, and review the gradation and density test data provided by the CQC Consultant. The CQA Consultant may conduct confirmation gradation and density testing as deemed appropriate.

4.2.2 Sump and LCR Pipe Drain Material

The drain material placed in the sumps and surrounding the LCR drainage pipe shall be placed in accordance with the project specifications. The CQC Consultant will provide gradation and mineralogical testing of the gravel material at the frequency specified in the project specifications. The CQA Consultant will observe that placement of the gravel is done in a manner to protect the geomembrane and plastic pipe and review the gradation and density test data provided by the CQC Consultant. The CQA Consultant may conduct confirmation gradation and additional testing as deemed appropriate.

4.3 RELATED MATERIALS

4.3.1 Geotextile Cushion and Filter Material

The geotextile cushion placed beneath the gravel drain material, and the geotextile filter placed between the sand drainage layer and the soil buffer layer shall be placed in accordance with project specifications. The CQA program for these materials is presented in Section 5.0 of this CQA Plan.

4.3.2 High Density Polyethylene (HDPE) Pipe Material

The perforated HDPE pipe placed within the gravel drain material shall be placed in accordance with project specifications. The CQA program for this material is presented in Section 6.0 of this CQA Plan.

4.3.3 Soil Buffer Layer Material

The soil buffer layer material shall be placed and compacted in accordance with project specifications. The CQC Consultant will provide classification testing of the material at the frequency specified in the project specifications. The CQA Consultant will observe that the placement of the soil buffer is done in a manner to protect the filter geotextile and review the classification data provided by the CQC Consultant. The CQA Consultant may conduct confirmation classification testing as deemed appropriate.

4.4 MATERIALS TESTING

4.4.1 Test Methods

All testing used to evaluate the suitability or conformance of LCR materials will be carried out in accordance with the project specifications.

4.4.2 Material Testing Requirements

The material CQC testing must comply with the minimum frequencies presented in the project specifications. The frequency of CQA testing will be determined by the CQA Consultant in light of the potential variability of the materials and the acceptance/failure rate of the CQC testing.

4.5 LCR CONSTRUCTION QUALITY ASSURANCE

CQA will be performed on all components of the LCR system construction. CQA evaluation will consist of: (1) monitoring the work and observing the CQC testing, and (2) performing laboratory and field conformance tests. Laboratory CQA conformance tests will be conducted on samples taken at the borrow source, stockpile, and during the course of work prior to construction. Field conformance tests will be conducted during the course of the work.

4.5.1 Monitoring

The CQA Consultant shall monitor and document the construction of all LCR components. Monitoring the construction work for the natural materials of the LCR system includes the following:

- reviewing CQC testing for gradation and other physical properties of the natural materials and compilation of the data;
- monitoring the minimum vertical buffer maintained between field equipment and the geomembrane; and
- monitoring the placement of the natural materials does not fold or damage the geomembrane in any way.

4.5.2 Deficiencies

If a defect is discovered in the earthwork product, the CQC Consultant will immediately determine the extent and nature of the defect and report it to the CQA Consultant. If the defect is indicated by an unsatisfactory test result, the CQC Consultant will determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate.

4.5.2.1 Notification

After determining the extent and nature of a defect, the CQC Consultant will notify the Project Manager and Contractor and schedule appropriate retests when the work deficiency is corrected. The CQA Consultant shall observe all retests on defects.

4.5.2.2 Repairs and Retesting

The Contractor will correct the deficiency to the satisfaction of the CQA Consultant. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the CQC Consultant will develop and present to the Project Manager suggested solutions for his approval.

All retests recommended by the CQC Consultant must verify that the defect has been corrected before any additional work is performed by the Contractor in the area of the deficiency. The CQA Consultant will verify that all installation requirements are met and that all submittals are provided.

4.5.2.3 Penalties

Refer to Specification Section 02775.

SECTION 5.0

GEOTEXTILE MATERIAL AND INSTALLATION QUALITY ASSURANCE

SECTION 5.0
GEOTEXTILE MATERIAL AND INSTALLATION QUALITY ASSURANCE

5.1 MANUFACTURING

The Contractor will provide the CQA Consultant with a list of guaranteed minimum average roll value" properties (as defined by the Federal Highway Administration), for the type of geotextile to be delivered. The Contractor will also provide the CQA Consultant with a written certification from the Geotextile Manufacturer that the materials actually delivered have "minimum average roll value" properties which meet or exceed all property values guaranteed for that type of geotextile.

The CQA Consultant will examine all manufacturer certifications to ensure that the property values listed on the certifications meet or exceed those specified for the particular type of geotextile. Any deviations will be reported to the Project Manager.

The inspection methods, handling techniques, and property values identified in this section for the filter geotextile shall also apply to geotextile portion of the geocomposite drain which will be heat bonded to the geonet (see Section 7.0 for more detail).

5.2 LABELING

The Geotextile Manufacturer will identify all rolls of geotextile in conformance with the project specifications. The CQA Consultant will examine rolls upon delivery and any deviation from the above requirements will be reported to the Project Manager.

5.3 SHIPMENT AND STORAGE

During shipment and storage, the geotextile will be protected as required by manufacturer's recommendations and the project specifications. The CQA Consultant will observe rolls upon delivery at the site and any deviation from the above requirements will be reported to the Project Manager.

5.4 HANDLING AND PLACEMENT

The Geosynthetic Installer will handle all geotextiles in such a manner as required by the project specifications. Any noncompliance will be noted by the CQA Consultant and reported to the Project Manager.

5.5 SEAMS AND OVERLAPS

All geotextiles will be seamed or overlapped in accordance with project specifications or as approved by the CQA Consultant and Engineer.

5.6 REPAIR

Any holes or tears in the geotextile will be repaired in accordance with the project specifications. The CQA Consultant will observe any repair and note any noncompliance with the above requirements and report them to the Project Manager.

5.7 PLACEMENT AND MATERIALS

All soil materials located on top of a geotextile shall be placed in accordance with the project specifications. Any noncompliance will be noted by the CQA Consultant and reported to the Project Manager.

SECTION 6.0

HIGH DENSITY POLYETHYLENE MANHOLES, PIPE AND FITTINGS CONSTRUCTION QUALITY ASSURANCE

SECTION 6.0

HIGH DENSITY POLYETHYLENE MANHOLES, PIPE AND FITTINGS CONSTRUCTION QUALITY ASSURANCE

6.1 MATERIAL REQUIREMENTS

All HDPE manholes, pipe, and fittings shall be produced in accordance with the project specifications.

6.2 MANUFACTURER

Prior to the installation of HDPE manholes or pipes, the Manufacturer will provide to the Contractor and the CQA Consultant the following:

- a properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the project technical specifications;
- a list of quantities and descriptions of materials other than the base resin which comprise the pipe;
- the sampling procedure and results of testing; and
- a certification by the HDPE Pipe Manufacturer that values given in the properties sheet are minimum values and are guaranteed by the HDPE Pipe Manufacturer.

The CQA Consultant will review these documents and verify that:

- the property values certified by the HDPE Pipe Manufacturer meet all of the project technical specifications; and
- the measurements of properties by the HDPE Pipe Manufacturer are properly documented and that the test methods used are acceptable.
- Report any discrepancies with the above requirements to the Project Manager.

6.2.1 Verification and Identification

Prior to shipment, the Contractor will provide the Project Manager and the CQA Consultant with a quality control certification for each lot/batch of HDPE pipe provided. The quality control certificate will be signed by a responsible party

employed by the HDPE Pipe Manufacturer, such as the Production Manger. The quality control certificate will include:

- lot/batch number and identification; and
- sampling procedures and results of quality control tests.

The CQA Consultant will:

- verify that the quality control certificates have been provided at the specified frequency for all lots/batches of pipe, and that each certificate identifies the pipe lot/batch related to it; and
- review the quality control certificates and verify that the certified properties meet the project technical specifications.

6.3 NONDESTRUCTIVE TESTING

6.3.1 Nondestructive Testing of Joints

All nonperforated HDPE joints must be nondestructively tested. These pipe joints will be tested using the pressure test as provided in the project technical specifications. Other nondestructive test methods may be used only when:

- the Geosynthetic Installer can prove its effectiveness;
- the method is approved by the Pipe Manufacturer; and
- the method is approved by the Engineer.

The Project Manager and the CQA Consultant will verify the effectiveness and validity of the alternative test method,

The CQA Consultant will report any nonconformance of testing methods to the Project Manager.

SECTION 7.0

HDPE GEONET CONSTRUCTION QUALITY ASSURANCE

Note: Throughout this section, references to geonet shall be interpreted and applied to the geonet portion of the geocomposite drain. The HDPE geonet will have a nonwoven geotextile heat bonded on each side to form the geocomposite drain. CQA considerations for the nonwoven geotextile are presented in Section 5.0.

SECTION 7.0
HDPE GEONET CONSTRUCTION QUALITY ASSURANCE

7.1 MATERIAL REQUIREMENTS

All HDPE geonet shall be produced in accordance with the project specifications.

7.2 MANUFACTURING

The Geonet Manufacturer will provide the Contractor and the CQC Consultant with a written certification, signed by a responsible party, that the geonets actually delivered have properties which meet or exceed the guaranteed properties.

The CQA Consultant will examine all manufacturer's certifications to ensure that the property values listed on the certifications meet or exceed the project specifications. Any deviations will be reported to the Project Manager.

7.3 LABELING

The Geonet Manufacturer will identify all rolls of geonet in accordance with project specifications. The CQA Consultant will examine rolls upon delivery and any deviation from the above requirements will be reported to the Project Manager.

7.4 SHIPMENT AND STORAGE

Geonet cleanliness is essential to its performance; therefore, the shipping and storage of geonet must be in accordance with the project specifications. The CQA Consultant will examine rolls upon delivery and any deviation from the above requirements will be reported to the Project Manager.

The CQA Consultant will verify that geonets are free of dirt and dust just before installation. The CQA Consultant will report the outcome of this verification to the Project Manager; and, if the geonets are judged dirty or dusty, they will be washed by the Geonet Installer prior to installation.

Washing operations will be observed by the CQA Consultant and improper washing operations will be reported to the Project Manager.

7.5 HANDLING AND PLACEMENT

The Geonet Installer will handle all geonets in a manner in accordance with the project specifications. The CQA Consultant will note any noncompliance and report it to the Project

Manager.

7.6 STACKING AND JOINING

When several layers of geonets are stacked, care should be taken to ensure that stacked geonets are placed in the same direction. A stacked geonet will never be laid in perpendicular directions to the underlying geonet (unless otherwise specified by the Engineer). The CQA Consultant will observe the stacking of geonets and will note any noncompliance and report it to the Project Manager.

Adjacent geonets will be joined according to construction drawings and project specifications. The CQA Consultant will note any noncompliance and report it to the Project Manager.

7.7 REPAIR

Any holes or tears in the geonet will be repaired in accordance with project specifications. The CQA Consultant will observe any repair, note any noncompliance with the above requirements, and report them to the Project Manager.

7.8 PLACEMENT OF SOIL MATERIALS

All soil materials placed over the geonet should be placed in accordance with project specifications so as to ensure:

- the geonet and underlying geomembrane are not damaged;
- minimal slippage of the geonet on the underlying geomembrane occurs; and
- no excess tensile stresses occur in the geonet.

Any noncompliance will be noted by the CQA Consultant and reported to the Project Manager.

SECTION 8.0

GEOSYNTHETIC CLAY LINER (GCL) MATERIAL AND INSTALLATION QUALITY ASSURANCE

SECTION 8.0
GEOSYNTHETIC CLAY LINER (GCL) MATERIAL AND INSTALLATION QUALITY ASSURANCE

8.1 MANUFACTURING

The Contractor will provide the CQA Consultant with a list of guaranteed "minimum average roll value" properties (as defined by the Federal Highway Administration) for the GCL to be delivered. The Contractor will also provide the CQA Consultant with a written certification from the GCL Manufacturer that the materials actually delivered have "minimum average roll value" properties which meet or exceed all property values guaranteed for the GCL.

The CQA Consultant will examine all manufacturer certifications to determine if the property values listed on the certifications meet or exceed those specified for the GCL. Any deviations will be reported to the Engineer.

8.2 LABELING

The GCL Manufacturer will identify all rolls of GCL in conformance with the project specifications. The CQA Consultant will examine rolls upon delivery and any deviation from the above requirements will be reported to the Engineer.

8.3 SHIPMENT AND STORAGE

During shipment and storage, the GCL will be protected as required by the project specifications. The CQA Consultant will observe rolls upon delivery at the site and any deviation from the above requirements will be reported to the Engineer.

8.4 HANDLING AND PLACEMENT

The Geosynthetic Installer will handle the GCL in such a manner as required by the project specifications. Any noncompliance will be noted by the CQA Consultant and reported to the Engineer.

8.5 SEAMS AND OVERLAPS

The GCL will be seamed or overlapped in accordance with project specifications or as approved by the CQA Consultant and Engineer.

8.6 REPAIR

Any holes or tears in the GCL will be repaired in accordance with the project specifications. The CQA Consultant will observe any repair and note any noncompliance with the above requirements and report them to the Engineer.

8.7 PLACEMENT AND MATERIALS

All soil materials located on top of the GCL shall be placed in accordance with the project specifications. Any noncompliance will be noted by the CQA Consultant and reported to the Engineer.

SECTION 9.0

SURVEYING CONSTRUCTION QUALITY CONTROL

SECTION 9.0
SURVEYING CONSTRUCTION QUALITY CONTROL

9.1 INTRODUCTION

Surveying of lines and grades is conducted on an ongoing basis during construction of the component liner and leachate collection systems. Close CQC of the surveying is absolutely essential to ensure that slopes are properly constructed. The surveying conducted at the site shall be performed by the Contractor.

9.2 SURVEY CONTROL

Permanent benchmarks and baseline control points are to be established for the site at locations convenient for daily tie-in. The vertical and horizontal controls for this benchmark will be established within normal land surveying standards.

9.3 SURVEYING PERSONNEL

The Contractor's survey crew will consist of a Senior Surveyor, and as many Surveying CQC Monitors as are required to satisfactorily undertake the requirements for the work. All Surveying CQC personnel will be experienced in the provision of these services, including detailed, accurate documentation.

All surveying will be performed under the direct supervision of a Registered Professional Engineer (PE) or Licensed Land Surveyor (PLS) licensed in the state in which the project is located. The Licensed Land Surveyor may be the Senior Surveyor.

9.4 PRECISION AND ACCURACY

A wide variety of survey equipment is available to meet the requirements of this project. The survey instruments used for this work should be sufficiently precise and accurate to meet the needs of the project. All survey instruments should be capable of reading to a precision of 0.01 foot and with a setting accuracy of 20 seconds. (5.6×10^{-3} degrees).

9.5 LINES AND GRADES

The following surfaces shall be surveyed to verify the lines and grades achieved during construction. The survey should at least include (as deemed appropriate by the Engineer and CQA Consultant):

- one or more construction baselines;
- a working grid with a sufficient number of benchmarks;

- surface of the subgrade;
- all existing structures;
- surface of the soil liner component;
- invert elevation of and location of leachate collection/header and force main piping at each lateral intersection and endpoint, and every 50 feet between the intersections and endpoints;
- inverts of sumps and manholes;
- surface of the leachate collection layer (protective cover);
- elevations of and locations of temporary berms;
- top/toe of all perimeter berms, roads, and channels;
- location of edge of liner, tie-in seam to adjacent existing liner system (as applicable);
- corners/intersections of all geosynthetic rolls or panels; and
- location of anchor trenches.

Laser planes are highly recommended for achieving the correct lines and grades during construction of each surface.

9.6 FREQUENCY AND SPACING

All surveying will be carried out immediately upon completion of a given installation to facilitate progress and avoid delaying commencement of the next installation. In addition, spot checks, as determined by the Senior Surveyor, CQA Consultant, or Project Manager, during construction may be necessary to assist the Contractor in complying with the required grades.

The following spacings and locations will be provided by the CQC Surveyor, as a minimum, for survey points:

- surfaces with slopes less than 10 percent will be surveyed on a square grid not wider than 100 feet;
- on slopes greater than 10 percent, a square grid not wider than 100 feet will be used, but, in any case, a line of survey points at the crest, midpoint, and toe of the slope will be taken;

- a line of survey points no farther than 100 feet apart will be taken along any slope break (this will include the inside edge and outside edge of any bench on a slope);

- a line of survey points not farther than 50 feet apart will be taken for all piping used for leachate collection/detection lines, in particular, at the lateral intersection and line end points;

- at a minimum, a line of survey points no farther than 50 feet apart will be taken for all cleanout risers;

- at a minimum, every 100 feet along the perimeter of the primary and secondary liner system; and

- at a minimum, a line of survey points no farther than 50 feet apart will be taken for all piping used for the leachate collection/detection lines.

9.7 THICKNESS MEASUREMENTS

The CQC surveyor as a representative of the Contractor shall obtain top and bottom elevations of the soil liner at a maximum 100-foot grid points and at all grade break lines prior to placement of the geomembrane liner system. The procedure for obtaining top and bottom elevations of the soil liner shall be agreed to by the CQA Consultant and Engineer prior to construction. The CQC Surveyor shall review the survey information with the Contractor to ensure that the survey demonstrates compliance with the project technical specifications. The Contractor is responsible for identifying and reporting to the CQA Consultant any areas of non-compliance evidenced by the survey, and for repairing such areas. The CQA Consultant and Contractor shall review the thickness measurements of the soil liner component prior to placement of the geomembrane liner.

9.8 TOLERANCES

Except for liner components where no minus tolerances are acceptable, the following are maximum tolerances for survey points:

- on surfaces, the maximum tolerances shall be 0.2 foot. This tolerance must be set to the record elevation of the surface below it and not the design elevation;

- on piping for leachate collection/detection lines, the maximum tolerance shall be 0.02 foot. This tolerance must be set to the record elevation of the surface below it and not the design elevation; and

- on cleanout risers, the tolerance shall be 0.2 foot This tolerance must be set to the record elevation of the surface below it and not the design elevation.

9.9 DOCUMENTATION

All field survey notes will be retained by the Senior Surveyor. The results from the field surveys will be documented on a set of Survey Record (As-Built) Drawings by the Contractor for submittal to the CQA Consultant. The Contractor shall certify to the CQA Consultant and Engineer that the results of the survey demonstrates compliance with the Contract Documents. These drawings shall, at a minimum, show the final elevations and locations of all surfaces and appurtenances surveyed in Subsection 2.5 of this CQA/CQC Plan.

SECTION 10.0

CONSTRUCTION QUALITY ASSURANCE DOCUMENTATION

SECTION 10.0
CONSTRUCTION QUALITY ASSURANCE DOCUMENTATION

10.1 DOCUMENTATION

An effective CQA plan depends largely on recognition of all construction activities that should be monitored and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance activities. The CQA Consultant will document that all quality assurance requirements have been addressed and satisfied.

This CQA plan integrates the testing and inspection performed by the CQC Consultant in accordance with the project specifications with the CQA overview and conformance testing performed by the CQA Consultant, in accordance with this CQA Plan.

The CQA Consultant will provide the Project Manager with the CQC Consultant's daily and weekly reports including signed descriptive remarks, data sheets, and logs to verify that all CQC monitoring activities have been carried out. The CQA Consultant will also provide the Project manager with a weekly report summarizing CQA activities and identifying potential quality assurance problems. The CQA Consultant will also maintain at the job site a complete file of Plans, Reports, project specifications, a CQA Plan, checklists, test procedures, daily logs, and other pertinent documents.

10.2 RECORDKEEPING

The CQC Consultant's reporting procedures will include preparation of a daily report which, at a minimum, will consist of: (a) field notes, including memoranda of meetings and/or discussions with the Contractor; (b) observation logs and testing data sheets; and © construction problem and solution data sheets. The daily report must be completed at the end of each CQC Consultant's shift, prior to leaving the site. This information will be submitted weekly to and reviewed by the CQA Consultant.

The CQC Consultant's weekly reports must summarize the major events that occurred during that week. Critical problems that occur shall be communicated verbally to the Project Manager or CQA Consultant immediately as well as being included in the weekly reports. The CQC Consultant's weekly report must be submitted to the CQA Consultant no later than the Monday following the week reported.

The CQA Consultant's weekly report must summarize the CQC Consultant's weekly and daily reports, CQA conformance testing activities, construction problems that occurred, and the resolution of construction problems. The CQA Consultant's weekly report should identify all potential or actual compliance problems outstanding. The CQA Consultant's weekly report must be submitted to the Project Manager on the Wednesday following the week reported.

10.2.1 Memorandum of Discussion with CQC Consultant or Geosynthetic Installer

A report will be prepared summarizing each discussion between the CQA Consultant and the CQC Consultant or Geosynthetic Installer. At a minimum, the report will include the following information:

- date, project name, location, and other identification;
- name of parties to discussion at the time;
- relevant subject matter or issues;
- activities planned and schedule; and
- signature of the CQA Consultant.

10.2.2 CQA Observation Logs and Testing Data Sheets

CQA observation logs and conformance testing data sheets will be prepared by the CQA Consultant on a weekly basis. At a minimum, these logs and data sheets will include the following information:

- an identifying sheet number for cross referencing and document control;
- date, project name, location, and other identification;
- data on weather conditions;
- a reduced-scale Site Plan showing all proposed work areas and test locations;
- descriptions and locations of ongoing construction;
- descriptions and specific locations of areas, or units, of work being tested and/or observed and documented;
- locations where tests and samples were taken;
- a summary of test results;
- calibrations or recalibrations of test equipment, and actions taken as a result of recalibration;

- off-site materials received, including quality verification documentation;
- decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality; and
- the CQA Consultant's signature.

10.2.3 CQA Construction Problem and Solution Data Sheets

CQA sheets describing special construction situations will be cross-referenced with specific CQA observation logs and testing data sheets, and must include the following information, where available:

- an identifying sheet number for cross referencing and document control;
- a detailed description of the situation or deficiency;
- the location and probable cause of the situation or deficiency;
- how and when the situation or deficiency was found or located;
- documentation of the response to the situation or deficiency;
- final results of any responses;
- any measures taken to prevent a similar situation from occurring in the future; and
- the signature of the CQA Consultant, and signature of the Project Manager indicating concurrence if required by this CQA Plan.

The Project Manager will be made aware of any significant recurring non-conformance with the project specifications. The Project Manager will then determine the cause of the non-conformance and recommend appropriate changes in procedures or specification. When this type of evaluation is made, the results will be documented, and any revision to procedures or project specifications will be approved by the Owner and Engineer.

10.3 CQA PHOTOGRAPHIC REPORTING DATA SHEETS

Photographic reporting data sheets, where used, will be cross-referenced with CQA observation logs and testing data sheets and/or CQA construction problem and solution data sheets. Photographs shall be taken at regular intervals during the construction process and in all areas deemed critical.

These photographs will serve as a pictorial record of work progress, problems, and mitigation activities. The basic file will contain color prints; negatives will also be stored in a separate file in chronological order. These records will be presented to the Project Manager upon completion of the project.

In lieu of photographic documentation, videotaping may be used to record work progress, problems, and mitigation activities. The Project Manager may require that a portion of the documentation be recorded by photographic means in conjunction with video taping.

10.4 DESIGN AND/OR PROJECT TECHNICAL SPECIFICATION CHANGES

Design and/or project specification changes may be required during construction. In such cases, the CQA Consultant will notify the Project Manager and the Engineer. The Project Manager will then notify the appropriate agency, if necessary.

Design and/or project specification changes will be made only with the written agreement of the Project Manager and the Engineer, and will take the form of an addendum to the project specifications. All design changes shall include a detail (if necessary) and state which detail it replaces in the plans.

10.5 CQA PROGRESS REPORTS

The CQA Consultant will prepare a summary progress report each week, or at time intervals established at the pre-construction meeting. As a minimum, this report will include the following information;

- a unique identifying sheet number for cross-referencing and document control;
- the date, project name, location, and other information;
- a summary of work activities during progress reporting period;
- a summary of construction situations, deficiencies, and/or defects occurring during the progress reporting period;
- summary of all test results, failures and retests, and

- signature of the CQA Consultant.

10.6 SIGNATURE AND FINAL REPORT

At the completion of each major construction activity at the landfill unit, the CQA Consultant will certify all required forms, observation logs, field and laboratory testing data sheets including sample location plans, construction problems and solution data sheets. The CQA Consultant will also provide a final report which will certify that the work has been performed in compliance with the plans and project technical specifications, and that the supporting documents provide the necessary information.

The CQA Consultant will also provide summaries of all the data listed above with the report. The Record Drawings will include scale drawings depicting the location of the construction and details pertaining to the extent of construction (e.g., depths, plan dimensions, elevations, soil component thicknesses, etc.). All surveying and base maps required for development of the Record Drawings will be done by the Construction Surveyor. These documents will be certified by the Contractor and CQC Consultant and delivered to the CQA Consultant and included as part of the CQA documentation (Certification) report.

It may be necessary to prepare interim certifications, as allowed by the regulatory agency to expedite completion and review.

10.7 STORAGE OF RECORDS

All handwritten data sheet originals, especially those containing signatures, will be stored by the Project Manager in a safe repository on site. Other reports may be stored by any standard method which will allow for easy access. All written documents will become property of the Owner.